BEST MANAGEMENT PRACTICES AND WASTELOAD REDUCTION

buttonwoods brewing | cranston, rhode island

The Rhode Island Department of Environmental Management (RIDEM) was awarded a US Environmental Protection Agency (EPA) Region 1 Pollution Prevention (P2) grant to study the effectiveness of brewhouse best management practices (BMPs) for reducing wastewater loadings from craft breweries. Upon receiving confirmation of the P2 Grant award, RIDEM reached out to craft breweries in RI to gauge interest in participating in this beneficial study. Weston & Sampson partnered with RIDEM to provide technical assistance on brewery BMPs.

The Brewery. Buttonwoods Brewery is a small craft brewery that opened in 2017 in Cranston, RI. Situated inside of a circa-1912 old mill building, the brewery was named "The Annex", after a section of Warwick, RI, where the owner's parents lived. Brewing everything from European-style lagers to farmhouse ales and New England IPAs, Buttonwoods quickly earned a good reputation for their products.

Buttonwoods' wastewater discharge permit, issued by the City of Cranston, requires access by the local pretreatment coordinators for routine effluent quality monitoring. Some of the results obtained from the analysis caused concern from both the brewery and the pretreatment coordinators. Buttonwoods learned of the RIDEM brewery wastewater assistance program through the Rhode Island Brewers Guild, and offered to participate in the study in an effort to see if there was a way to reduce their wastewater strength through internal Best Management Practices (BMPs), and serve as an example to help benefit local craft brewers.

The brewery consists of a 3.5-barrel (BBL) brewhouse with 10-barrel fermenters, averaging an annual production rate of 1,405 BBL/year of beer. In addition, the facility has a taproom which discharges to the municipal wastewater collection system. Reported facility water consumption averages approximately 163,609 gallons/year. Some of the water becomes finished product. Buttonwoods has reported 2,401 gallons/week of wastewater discharged over a two-week recording period. This equates to 120,059 gallons of wastewater per year (assuming 50 brewing weeks per year). Comparing the actual measured wastewater generation rate to the annual production of beer, wastewater from the facility generates at a rate of 2.76 barrels of wastewater for every barrel of beer produced - significantly more efficient than our observed craft brewing industry average of 5:1.

Weston & Sampson and representatives from the RIDEM met on-site with the owner to review brewing operations, identify locations and processes which contributed to the high strength wastewater flows, and to develop a list of suggested BMPs which could be implemented within the brewhouse to reduce overall organic load.

The Study. Phase I of the study consisted of identifying potential sampling locations and taking representative composite samples of industrial effluent from Buttonwoods' brewing operation. Unfortunately, all drainage from the brewing operation, both brewing and cellaring, pass through a short trench drain. This drain is connected to a P-trap in the drain line beneath the brewhouse slab and did not provide adequate access or a sufficient volume for representative sampling of brewery wastewater. Sewer manholes outside of the brewery were influenced by discharges from other sources within the industrial complex where Buttonwoods is situated.

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Therefore, representative sampling of their effluent could not be obtained for this study.

Due to the size of the brewery, the small volumes of wastewater discharged, and the close control the brewer had over the manual brewing process, allowed us the opportunity to identify load fractions for each of the brewing processes. The configuration of the brewing equipment allowed us to obtain two rounds of wastewater grab samples from each of the specific brewing processes noted below:

- Keg Washing CIP – This includes residual beer, as well as spent CIP washwater from returned beer kegs.
- Canning Line Discharge – Foam-over and can rinse collected during the canning process.
- CIP Discharge – After final cleaning and sanitizing of the fermenters.
- Fermenters First Rinse - After fermented beer is transferred to canning, but before the CIP system is connected to the vessel.
- Mash Tun First Rinse – After wort is transferred and the spent grain has been removed, but before the Clean-in-Place (CIP) system is connected to the vessel.
- Taproom Waste Beer – Line purge from priming beer taps and waste beer from partially consumed drafts.

The following graphs depict constituent loadings from the sampling program, taken over the course of two weeks. Ideally, adding up the total loads from each sample area should be close to the total loading from the brewery. Variability in brewing operations, seasonal variability in product and production, and the limited number of analyses at each discharge location contributed to the lack of resolution. However, we are able to see where the bulk of the loadings for each constituent are generated through the brewing and cellaring processes.

Figure 1: Biochemical Oxygen Demand (BOD)

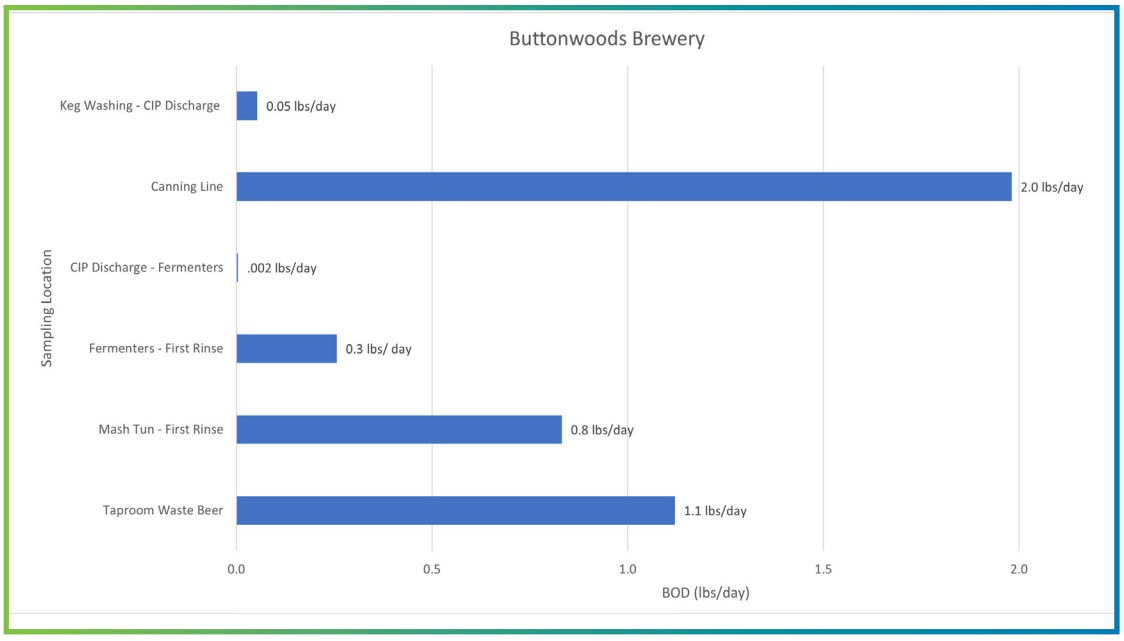

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Figure 2: Total Suspended Solids (TSS)

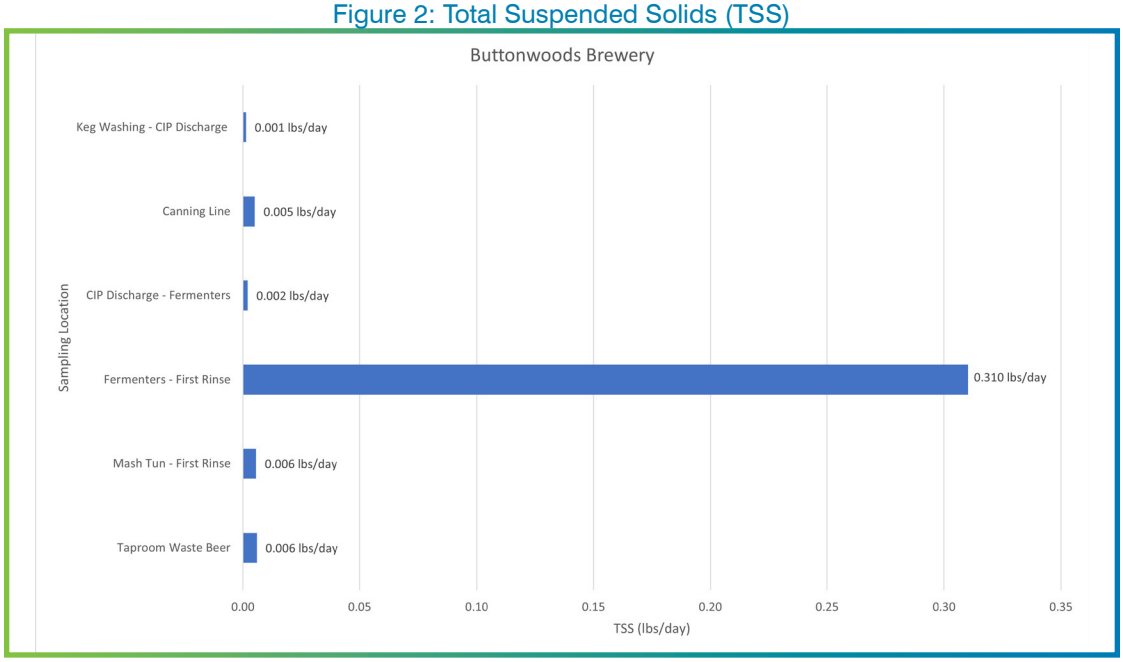

Figure 3: Phosphorus

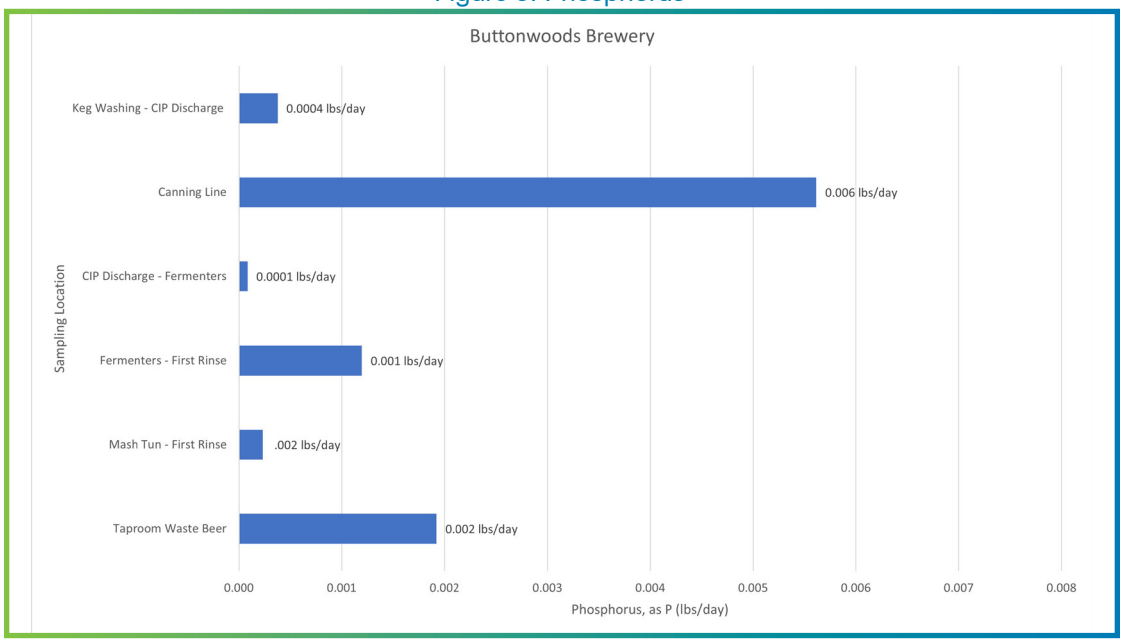

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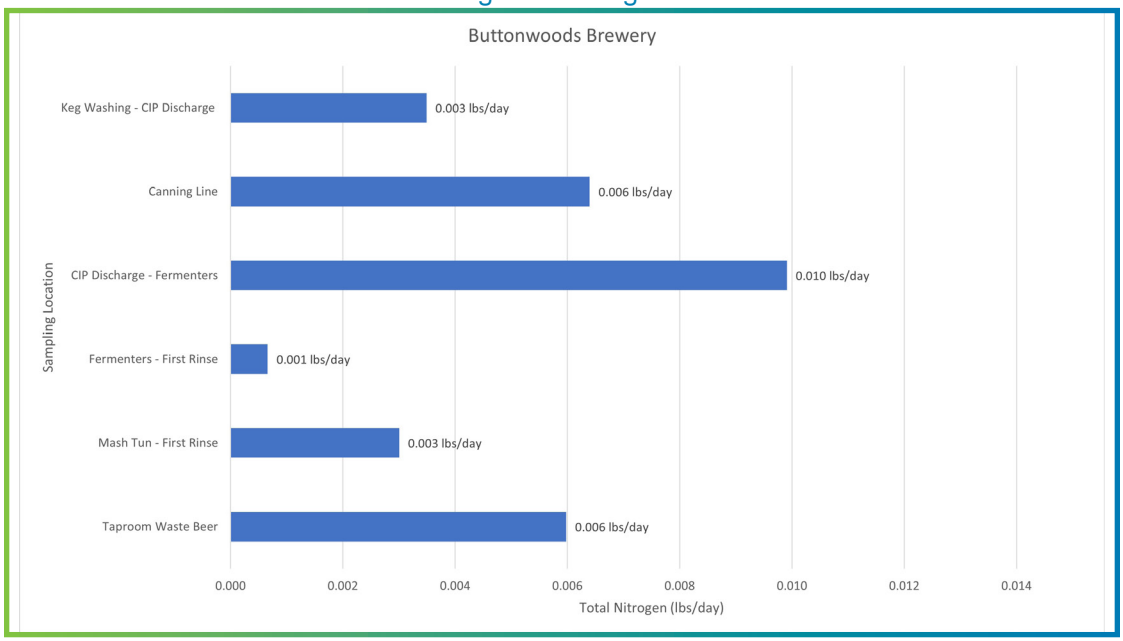
Figure 4: Nitrogen



Most municipal wastewater treatment facilities are concerned with organic, oil and grease, solids, and nutrient loadings from industrial dischargers - breweries not typically being a source of oils and grease. From a review of our study data, we can observe that a significant contributor of organic load, Biochemical Oxygen Demand (BOD) *(Figure 1)*, at Buttonwoods is Canning Line wastewater, followed closely by Taproom Waste Beer. For Total Suspended Solids (TSS) *(Figure 2)*, the most significant contributor is Fermenter First Rinse. Most of the nutrient loadings (Phosphorus *(Figure 3)* and Nitrogen *(Figure 4)*) are from the Fermenter First Rinse and Fermenter CIP Discharge.

More generally, we see that implementing internal BMPs keep beer product from entering the wastewater, serving to have the largest reduction in organic load.

Cost Considerations. Brewery BMPs serve as low-cost operational improvements which will result in a significant reduction in sewer surcharge costs. The New England Interstate Water Pollution Control Commission (NEIWPCC) states that the average concentrations of BOD and TSS in domestic wastewater are 250 milligrams per liter (mg/l) and 300 mg/l, respectively. Wastewater generators whose discharge characteristics exceed these limits are typically subject to a surcharge based on the cost of treating the additional organic load above the average organic loadings noted above. The City of Cranston assesses surcharges for BOD loadings above 230 mg/L and does not currently assess a TSS surcharge. Buttonwoods is not currently assessed a surcharge due to its low wastewater generation rate.

Since the brewery is small and has no actual sewer surcharges to use as a starting point, we are providing the calculation below to show potential savings from implementing the BMPs highlighted above. As noted earlier, subtracting actual beer production from water use results in an average wastewater generation rate of 2,401 gallons of wastewater per operating week. Using a reported average Wastewater BOD of 12,750 mg/L, their BOD mass loading is likely 51 lb/day before any process sidestreaming. Since they ultimately would only pay a surcharge on loadings in excess of 230 mg/L, approximately 50 lb/day would be used in this BOD surcharge calculation. The City of Cranston currently assesses a surcharge for BOD at $0.114 per lb/day. The theoretical surcharge value for Buttonwoods would be close to $2,080 per year above their annual sewer bill. Since Buttonwoods discharges little wastewater, they do not currently receive a surcharge. This calculation is to provide an approximate value for the wastewater strength and value for the waste strength reduction through BMPs.

Using the limited data, we were able to gather if Buttonwoods could sidestream their three (3) significant organic load generators (Taproom Waste, Mash Tun First Rinse, and Canning Line Wastewater) they could potentially see a 3.9 lb/day or 8% reduction in BOD concentrations in wastewater from their current brewing operation. Reducing their total BOD load of 51 lb/day by 3.9 lb/day (via these BMPs), then subtracting the allowable BOD Load (based on 230 mg/L) covered by the base sewer billing rate, would leave 46.1 lb/day to which a surcharge could be applied. At $0.114/lb/day this is equivalent to a savings of $0.44/day ($162/year), based on BOD alone. While this does not seem like a lot of money, it does represent an 8% organic load reduction and commensurate reduction in wastewater surcharge. Similar results could be anticipated from a much larger craft brewing operation implementing the same basic BMPs noted above.

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Conclusion. Buttonwoods Brewery provided us with a great opportunity to observe: (1) which individual brewing processes generate high-strength wastewater, (2) how different brewing processes contribute higher concentrations of different constituents, and (3) the relative impact of implementing BMPs in these various areas of their facility. Should BMPs be implemented throughout the brewery and taproom, we expect that significant wasteload reductions can be achieved.

In a much larger facility, pretreatment may be required to bring effluent organic loadings to within local discharge permit constraints. Implementing brewing and cellaring BMPs will significantly reduce the implementation costs for such a pretreatment system.

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